The HP-IL
Interface Kit Technical Guide

HEWLETT PACKARD

HP 82166C
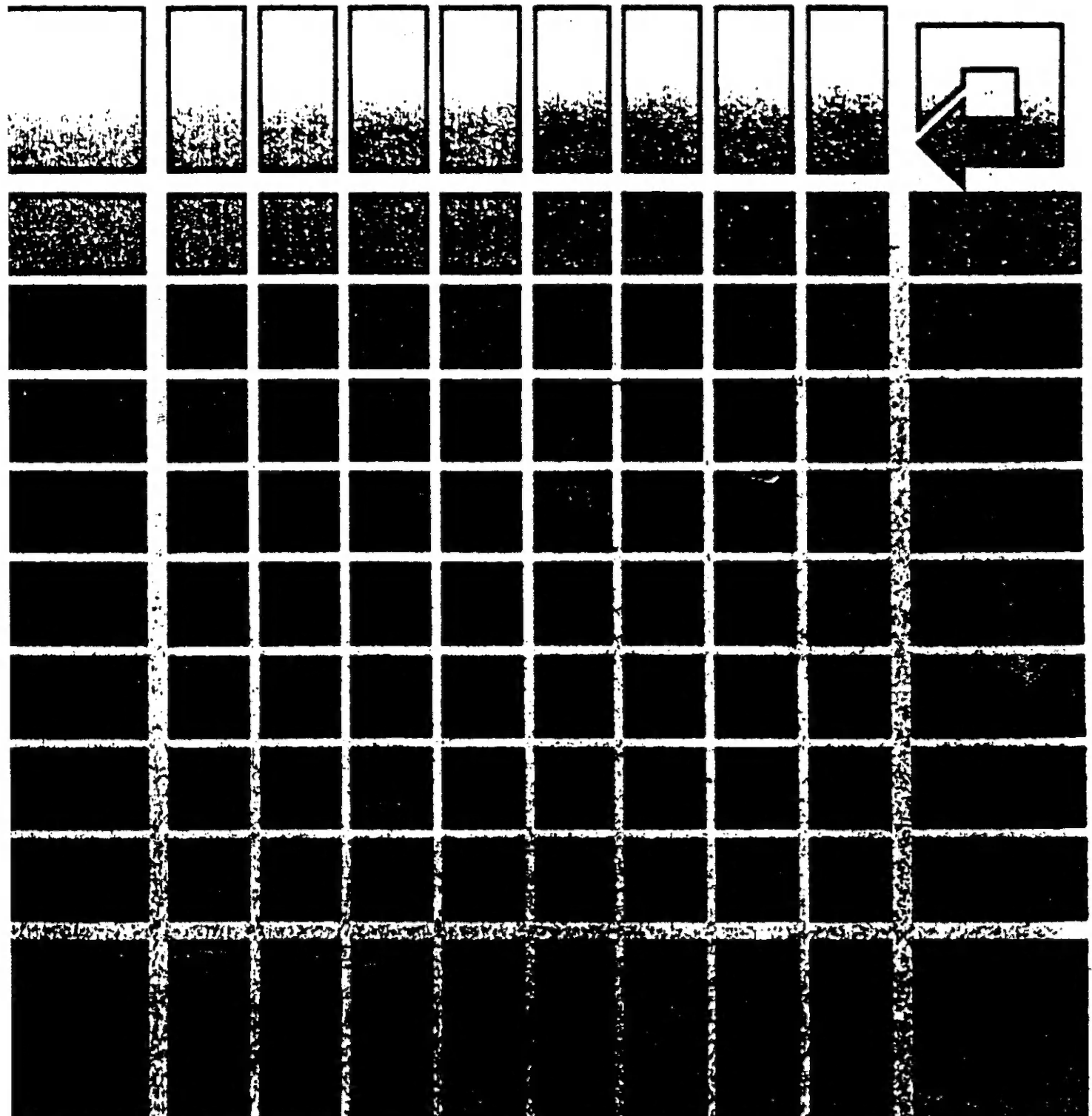
HP-IL INTERFACE KIT

Technical Guide

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INTRODUCTION

HP-IL, the Hewlett-Packard Interface Loop, is a digital communication system designed primarily for portable devices. It combines in one interface the attributes of low power, small size, and low cost. In terms of data rate, distance, and number of devices, HP-IL has several advantages over the common serial interface. The HP-IL protocol is based on and is very similar to that used in HP-IB (Hewlett-Packard Company's implementation of IEEE std 488). While its design center is portable devices, the HP-IL interface is quite general in capability and will provide efficient communication for a broad range of devices in diverse applications.

The HP 82166C HP-IL Interface Kit provides the necessary hardware, documentation, and support to allow you to design and build a prototype HP-IL interface as an integral part of your special device. This will permit your device to send and receive data from other HP-IL devices as well as allowing it to be controlled by HP-IL controller devices. Furthermore, you can even design the controller capability into your device using the component parts in this kit.

PARTS LIST AND DESCRIPTION

Many of the components used in the HP-IL interface are standard parts which are widely available. Some are specially designed for HP-IL such as the HP-IL integrated circuit. This section will provide you with the information you need to specify those standard parts in your interface as well as to assure yourself that the interface kit has no missing parts. The quantity of each part included in the interface kit and the Hewlett-Packard part number in parentheses are given in each case for reference purposes. The connection diagrams for the interface are found on pages 12-13 of this guide.

While most of the standard parts can be purchased from Hewlett-Packard, you will be able to acquire them at much lower cost from other vendors who normally provide that service. The special parts are available from Hewlett-Packard and will be available from alternate sources in the future as well.

Standard Parts

- Capacitor, .1 microfarad, quantity 4 (0160-0576)

- Capacitor, 10 microfarad, quantity 4 (0180-3135)

These two capacitors provide low frequency filtering and high frequency bypass for the power supply to the HP-IL interface. They are not part of the interface proper nor is their use critical. Their use will help strengthen your device's noise immunity.

- Capacitor, 120 picofarad, 5%, quantity 4 (0160-4800)

- Inductor, 56 microhenry, 5%, quantity 4 (9100-1631)

- Crystal, 4 megahertz, quantity 2 (0410-1305)

The capacitor and inductor are connected as a parallel LC network to set the frequency of the HP-IL integrated circuit oscillator at 2 megahertz. The inductor should have a maximum DC resistance of 3 ohms. The crystal controls the frequency of the oscillator on the microprocessor integrated circuit.

- Resistor, 15 kilohms, 5%, .25 watt, quantity 8 (0683-1535)

- Resistor, 383 ohms, 1%, .125 watt, quantity 8 (0698-3446)

- Capacitor, 330 picofarad, 5%, quantity 8 (0160-4292)

- Zener diode, 6.2 volt, 1N753A, quantity 8 (1902-0953)

- Zener diode, 33 volt, 1N973B, quantity 8 (1902-0970)

These components are part of the interface itself. The 15 kilohm resistors provide the proper load for the HP-IL input. The 383 ohm resistors and the 330 picofarad capacitors form a simple impedance matching low-pass network for the HP-IL output. The diodes provide ESD (electrostatic discharge) protection for both the HP-IL inputs and outputs. These types of diodes were selected for their low capacitance. Other types of diodes should not be used in their place.

NOTE: Later interface kits may have the HP-IL hybrid network instead of these separate interface components. This part is described in the following section.

● Screw, 2-28 self-tapping, quantity 8 (0624-0302)

● Washer, flat, quantity 8 (3050-0626)

The screws and washers are included to give you a way to conveniently mount the HP-IL panel receptacle described in the following section.

Special Parts

● HP-IL hybrid network, quantity 4 (1810-0651)

This part is substituted for the interface components listed at the end of the preceding section in interface kits assembled after the second quarter of 1983. It will also be available as an individual component for use in HP-IL devices after that time. It provides all the discrete interface components in a single, convenient, space-saving package.

● HP-IL panel receptacle, quantity 4 (0950-0852)

This part insures a compatible mechanical interface to the HP-IL system for your device. It includes both the input and output connectors in a single, panel-mounted, molded-plastic part. Matching HP-IL cables with integral cable connectors are available separately under the following model numbers:

HP 82167A	.5 meter cable
HP 82167B	1 meter cable
HP 82167D	5 meter cable

The 5 meter cable may not be available in all countries.

● HP-IL pulse transformer, quantity 4 (9100-4226)

This specially designed pulse transformer set provides in a single package the necessary isolation and voltage conversion from HP-IL levels to the integrated circuit logic levels.

● HP-IL integrated circuit, quantity 4 (1LB3-0003)

This integrated circuit provides a simple, logical interface from a microprocessor to the HP-IL system. It is

designed to easily connect to most standard microprocessors.

- Microprocessor integrated circuit, quantity 2 (1820-2810)

This integrated circuit is included so that you can have
the option of implementing an HP-IL interface which duplicates
the function of the HP 82166A HP-IL Converter.

The module for the HP-41 and the magnetic cards for the
HP-75 are described with their corresponding manuals in the
following section.

DOCUMENTATION GUIDE

In addition to the parts, several manuals are included in
your interface kit to provide the necessary information and
support for a successful HP-IL interface design. This section
will describe those documents and help you to plan your study
of HP-IL prior to beginning the design.

The Three Primary Documents

- The HP-IL System: An Introductory Guide to the
  Hewlett-Packard Interface Loop

If you are not familiar with HP-IL you should carefully
study this book first. The reader is taught the fundamentals of
HP-IL with diagrams and examples. Each chapter progresses to
a more detailed description of the protocol. The basic ideas in
using the loop at the product level and at the component level
are described. Additional copies are available from
Osborne/McGraw-Hill, Berkeley, California.

- The HP-IL Interface Specification (82166-90017)

This document is the official definition of HP-IL. It has
detailed descriptions of the functional, electrical, and
mechanical characteristics of the device interface necessary to

be compatible with HP-IL. You will need to study this material carefully and be thoroughly familiar with it in order to properly implement the HP-IL interface in your device. This manual is quite similar in form and content to the IEEE std 488 document.

● The HP-IL Integrated Circuit User's Manual (82166-90016)

The details of the HP-IL integrated circuit are presented in this manual including specifications and hardware and software design examples and pointers. After learning about HP-IL in general in the first two documents, this document concentrates on the particular implementation of the HP-IL interface that you can design into your device using the 1LB3-0003 HP-IL integrated circuit.

Support Documents

● HP 82166A HP-IL Converter Technical Manual (82166-90002)

● HP 82165A/HP 82166A Manual Supplement (82165-90012)

One of the design alternatives available in the interface kit is to implement the equivalent of the HP 82166A HP-IL Converter in component form. The converter manual and its supplement are included for your convenience should you decide to choose this course of action.

● HP-IL Development Module and Owner's Manual (00041-15043)

This module plugs into an HP-41 Handheld Computer and together with the HP 82160A HP-IL Module for the HP-41 provides a very capable debugging tool for HP-IL systems. It allows you to see what HP-IL messages are being transmitted on the loop and permits software simulation of simple devices. The interface kit includes two of the development modules and one owner's manual to describe their usage and function.

● I/O Utilities and Solution Book (00075-13013)

● RIOWIO Utility and Instruction Card (00075-13014)

These two programs on magnetic cards and their corresponding manuals are used with the HP-75 Portable Computer. The I/O

utilities program provides the HP-75 with a general set of HP-IL I/O commands. The RIOWIO utility program gives the HP-75 a set of functions that allow you to interact directly with the HP-IL integrated circuit in the HP-75. These programs do not provide the same debugging and development tools as the HP-41 module. You could write a program that did have these capabilities, however, by using the functions in the RIOWIO utility.

DESIGN ALTERNATIVES

HP-IL can be used at various levels. The simplest way is to purchase ready-made devices with designed-in HP-IL interfaces that solve your problem. This may be a relatively costly method, but it provides a rapid solution and requires the least engineering effort. Only the system integration and the application software must be taken care of. This works fine for many end users of HP-IL.

Sometimes the end user's problem cannot be handled by available HP-IL devices. In this situation, a stand-alone interface from HP-IL to one of the other common interfaces may provide access to the needed devices. Interfaces from HP-IL to GPIO (8 or 16 bit parallel), HP-IB (Hewlett-Packard's implementation of IEEE std 488), and RS-232-C are or shortly will be available. The cost, time, and engineering effort required at this level are essentially the same as with available HP-IL devices.

At the next level, an HP-IL interface designed as an OEM component can be purchased and incorporated into an existing or newly-designed special device. The HP 82166A HP-IL Converter exemplifies this approach. It provides the same features as the HP 82165A HP-IL/GPIO Interface, but in a much smaller package without power supply or buffers. It is suitable and convenient for inclusion within a device. This method is ideal for the end user who must design special equipment to satisfy his needs and the device manufacturer whose product is relatively low volume and is somewhat insensitive to cost, power, and size. The time and engineering investment will be somewhat larger since the interface component must be incorporated inside the device. However, communication from the device to the interface is still very simple, and there is no worry about HP-IL

compatibility since the interface component takes care of those problems automatically.

The interfacing alternatives discussed to this point are already available. This interface kit provides two additional levels which have unique advantages in special cases. Most HP-IL device manufacturers and a few end users will be able to make use of these two other methods.

The kit contains the individual components to allow you to duplicate the functions of the HP 82166A HP-IL Converter. The microprocessor integrated circuit and the HP-IL integrated circuit are identical to those used in the converter. By designing these components into your device you have most of the advantages of the converter, but at substantially lower cost. You still need not worry about the HP-IL protocol, and the simple communication between the device and the interface is retained. However, you will need to take more care in the electrical design of the interface since you are working with individual parts.

If you need the maximum in flexibility from HP-IL, you will need an interface at the lowest level. By using the HP-IL integrated circuit and providing your own microprocessor, you can give the interface whatever functions you need for your special device. For example, the converter only allows your device to be a talker or listener. If you want your device to be the loop controller, you will need to interface at this more flexible level. Your microprocessor can control the device as well as the interface. You will have to write the microprocessor program very carefully so that it implements correct HP-IL protocol. This interface techique gives the optimum in low cost, power, and size but requires the maximum engineering investment.

CONNECTION DIAGRAMS

The diagrams on pages 10-11 provide the information needed to properly connect the parts in your HP-IL interface. Figure 1 shows that portion of the interface from the HP-IL panel receptacle to the HP-IL integrated circuit. This is sufficient if you are providing your own microprocessor. You will need to properly connect your microprocessor to the pins of the HP-IL integrated circuit which have no connection shown in figure 1.
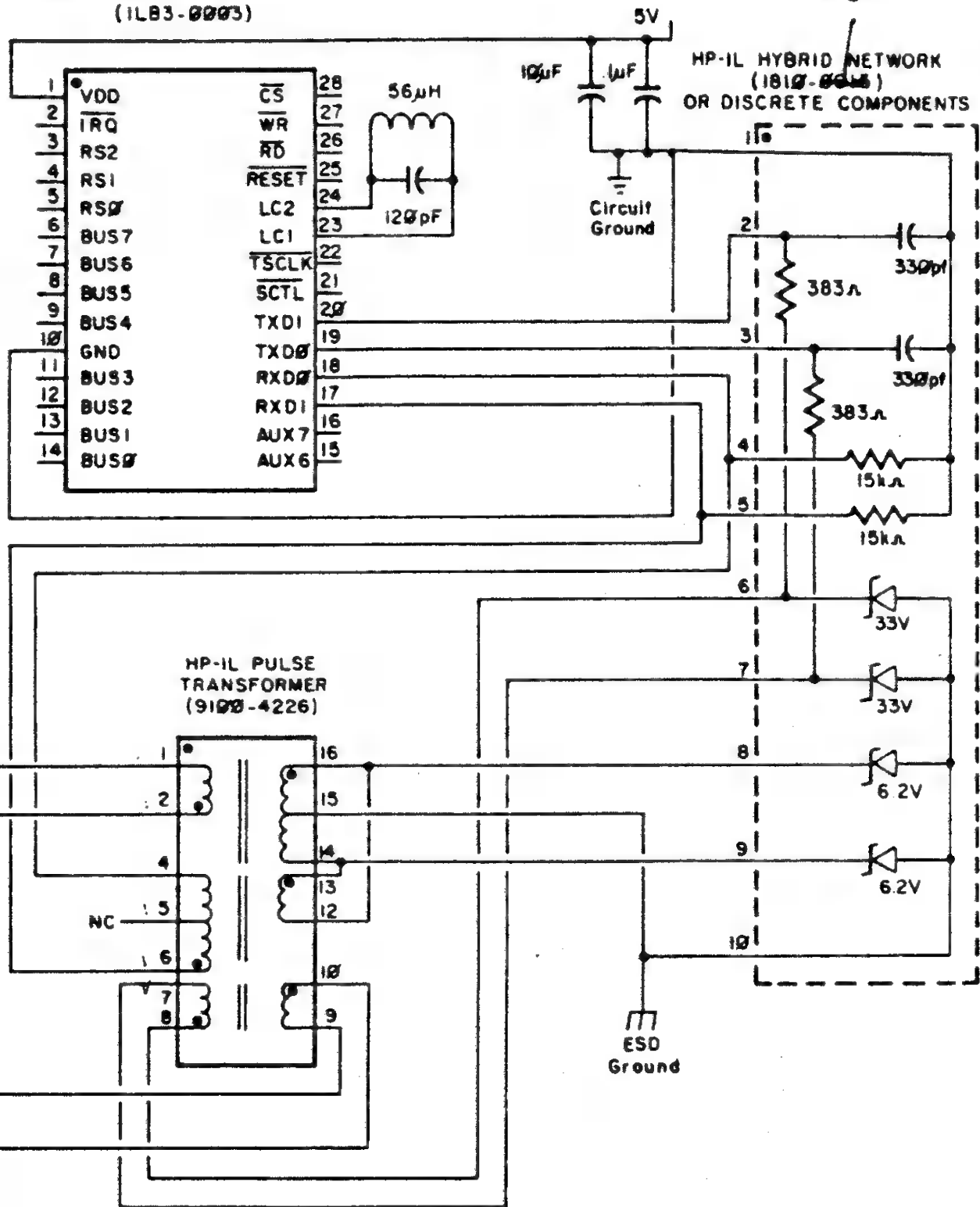
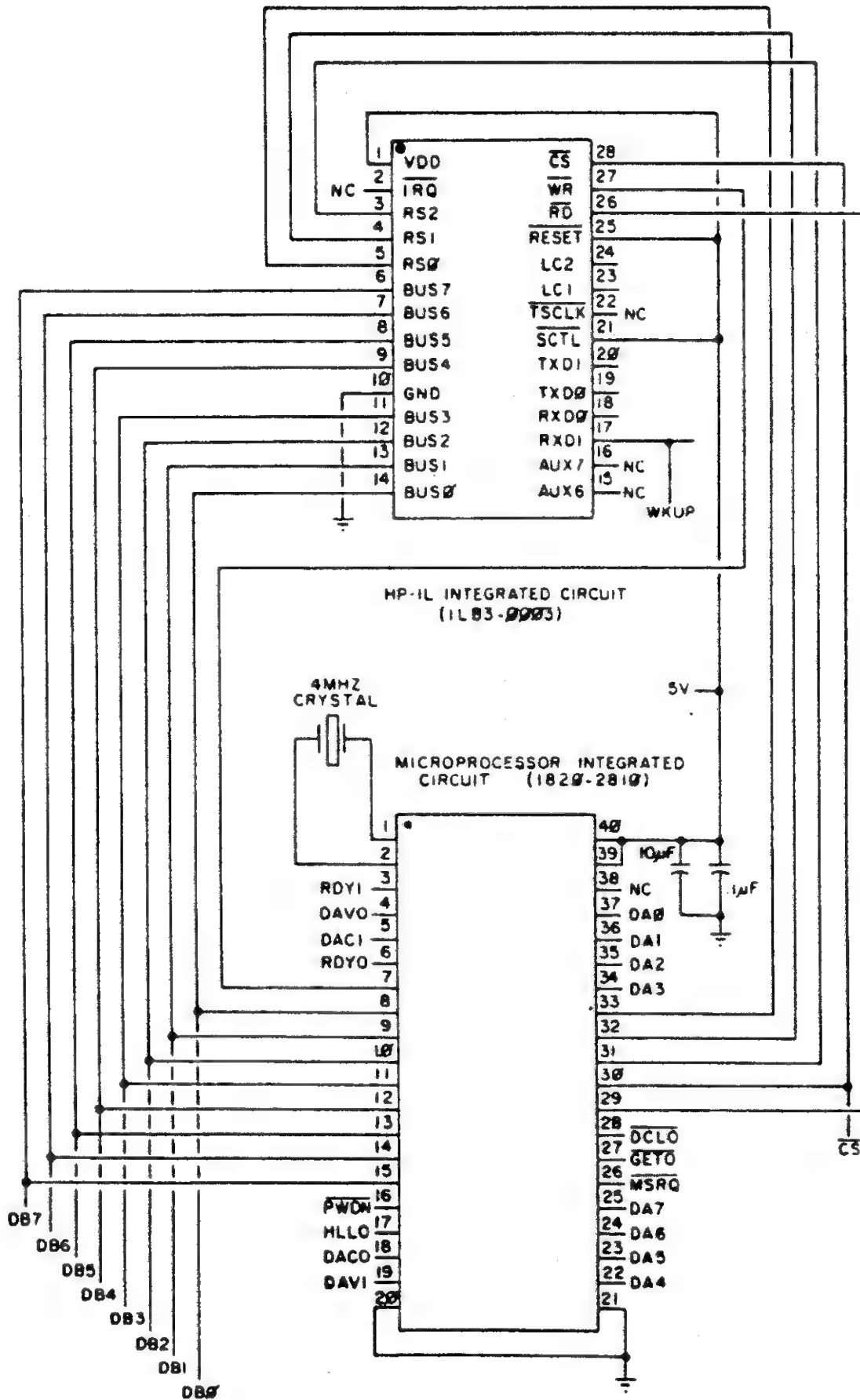**Figure 1: HP-IL Interface Connection Diagram**

Figure 2: HP-IL Converter Microprocessor Connection Diagram

These connections may vary depending on the particular type of microprocessor that you choose. If you decide to duplicate the functions of the HP-IL converter by using the 3870/20 type microprocessor provided in the kit, you should connect it to the HP-IL integrated circuit as shown in figure 2. The connections from the HP-IL integrated circuit to the panel receptacle are not shown in figure 2. They are the same as in figure 1. The electrical connections for the external pins of the converter are also shown in figure 2.

You will need to adhere to good printed-circuit board design and layout practices for the final version of your interface in order to obtain the best protection against ESD and electrical noise. The following comments should help you to do this.

Grounding is extremely important. You will note that in figure 1 different symbols are used for ESD ground and circuit ground. These two grounds should only be connected at one point, the place where the device ground originates. This might be the power supply rectifier negative terminal or the battery negative terminal. The printed-circuit traces for the ESD ground should be as short and wide as possible and should be separated as far as possible from the rest of the circuit. An additional shield ground could be used between ESD ground and the rest of the circuit if desired (also connected only at the single ground point). A metallic case and the earth ground connection if used should also be connected only at the single ground point.

The .1 microfarad bypass capacitor should be connected as closely as possible to the integrated circuits' power supply pins. The power supply traces should also be as wide and short as possible.

The lines from the HP-IL panel receptacle to the pulse transformer should be short and as far as possible from the rest of the circuit since the full force of an ESD pulse may be on these lines.

Because the incoming HP-IL signal is low-level, you should try to minimize the capacitive loading on the RXD0 and RXD1 pins of the HP-IL integrated circuit. Short, narrow traces are in order here. If you implement the HP-IL power down function in your device you will need to design a trigger circuit which monitors the RXD0 or RXD1 pin and intitiates the power-on sequence when any pulse is received. The HP-IL integrated circuit does not handle this function automatically. The loading of this circuit on RXD0 or RXD1 must be kept to a minimum.

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ORDERING INFORMATION

In order to obtain other information such as prices and quantity discounts, or to order additional interface kits, HP-IL documentation, HP-IL development modules for the HP-41, or the individual HP-IL component parts, contact your nearest Hewlett-Packard field sales representative. Alternatively, you can obtain ordering information by contacting:

> Hewlett-Packard Corporate Parts Center
> 333 Logue Ave.
> Mountain View, California 94043
> Telephone: (415) 968-9200

To obtain additional copies of the HP-75 magnetic cards and corresponding manuals in the interface kit you should contact:

> Hewlett-Packard Corvallis Division
> User's Library
> 1000 N.E. Circle Blvd.
> Corvallis, Oregon 97330
> Telephone: (503) 757-2000

If you have technical difficulties in the use of your HP-IL components which cannot be resolved by the documentation included in the interface kit you may contact:

> Hewlett-Packard Corvallis Division
> Systems Engineering
> 1000 N.E. Circle Blvd.
> Corvallis, Oregon 97330

LICENSING REQUIREMENTS

Hewlett-Packard Company is committed to the goal of having all HP-IL devices compatible with each other (as defined in "The HP-IL Interface Specification") whether manufactured by Hewlett-Packard Company or someone else. To this end, Hewlett-Packard Company desires to license manufacturers of HP-IL component parts. Terms will be negotiated on an individual basis.

Hewlett-Packard Company does not plan to require you to negotiate a license to manufacture or sell complete HP-IL devices which use these licensed components, however. Nevertheless, Hewlett-Packard Company is strongly interested in maintaining the compatibility of all HP-IL devices.

WARRANTY INFORMATION

What We Will Do

The HP 82166C Interface Kit and the individual HP-IL component parts when purchased from Hewlett-Packard are warranted against defects in materials and workmanship for 90 days from the date of original purchase. During the warranty period, we will replace at no charge a component that proves to be defective, if you return the unit, shipping prepaid, to Hewlett-Packard. This warranty extends only to Hewlett-Packard customers.

What Is Not Covered

This warranty does not apply if the product has been damaged by accident or misuse. This warranty also does not cover the software content in the kit or in the components.

No other express warranty is given. The replacement of a component is your exclusive remedy. ANY OTHER IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS IS LIMITED TO THE SPECIFIED DURATION OF THIS WRITTEN WARRANTY. Some states, provinces, or countries do not allow limitations on how long an implied warranty lasts, so the above limitation may not apply to you. IN NO EVENT SHALL HEWLETT-PACKARD COMPANY BE LIABLE FOR CONSEQUENTIAL DAMAGES. Some states, provinces, or countries do not allow the limitation or exclusion of incidental or consequential damages, so the above limitation or exclusion may not apply to you.

This warranty gives you specific legal rights, and you may also have other rights which vary from state to state, province to province, or country to country.

Warranty for Consumer Transactions in the United Kingdom

This warranty shall not apply to consumer transactions and shall not affect the statutory rights of a consumer. In relation to such transactions, the rights and obligations of the Seller and Buyer shall be determined by statute.

Obligation to Make Changes

Products are sold on the basis of specifications applicable at the time of manufacture. Hewlett-Packard shall have no obligation to modify or update products once sold.

Further Information

If you have any questions concerning this warranty, please contact an authorized Hewlett-Packard sales and service office. Should you be unable to contact them, please contact:

● In the United States:

> Hewlett-Packard Corvallis Division
> 1000 N.E. Circle Blvd.
> Corvallis, Oregon 97330
> Telephone: (503) 758-1010
> Toll-free Number: (800) 547-3400 (except in
>   Oregon, Hawaii, and Alaska)

● In Europe:

        Hewlett-Packard S.A.
        7, rue du Boi-du-lan
        P.O. Box CH-1217 Meyrin 2
        Geneva, Switzerland
        Telephone: (22) 83 81 11

        Note: Do not send warranty units to this address.

● In other countries:

        Hewlett-Packard Intercontinental
        3495 Deer Creek Rd.
        Palo Alto, California 94304
        USA
        Telephone: (415) 857-1501

        Note: Do not send warranty units to this address.